February 13, 1956

DIVISION OF PHARMACOLOGY and
PESTICIDE BRANCH

Division of Food

Evaluation of data on residues from fumigation with
liquid HCN, submitted in pesticide petition No. 38,
American Cyanamide Company

Exposure of food products to HCN occurs under three typical circumstances:

1. Warehouse fumigation, where exposure of stored commodities is only incidental, in the sense that the objective is primarily to control infestation of the premises. Complete kill, either of general infestation or of that in stored commodities, by warehouse fumigation, is normally impracticable. Standard dosage is 8 oz./1000 cu. ft. of gross enclosed space, for 24 hrs. at temperatures above 65°F. These are little more than reference conditions, however, as various factors dictate substantial deviation from standard dosage and exposure interval. At the greatest deviation, however, dosage generally remains below that employed for strictly commodity fumigation.

2. Atmospheric chamber fumigation effects complete kill in commodities that are not so dense as to seriously impede fumigant penetration. Dosage ranges from 1 to 3 lb./1000 cu. ft. of chamber space, for 12-48 hours.

3. Vacuum chamber fumigation consists essentially of withdrawing air from interstices of the product before administering the fumigant, to the end that it penetrates more deeply and promptly. Maximum dosage, for very dense products like bagged flour, is 5 lb./1000 cu. ft. of chamber space. Maximum for any of the products under this petition is no more than 4 lb. With this process a relatively short exposure interval suffices--2 to 4 hours. Commodities of low enough density for fumigation in atmospheric chambers are often vacuum fumigated because of the time saved. Even so, it appears that the dosage they receive in vacuum fumigation is generally higher.

Vacuum fumigation appears likely to give rise to higher residues than the other two types because of its usually higher dosage and the better penetration obtainable. The shorter exposure may be a factor counteracting the higher dosage. It is known, however, that the major part of such absorption as will occur, does occur within the first few hours. The counteracting influence of shorter exposure is therefore of minor importance.

It is usual to re-evacuate the chamber after the exposure period. It can be visualized that this might diminish the amount of absorbed fumigant. Griffin and Back (USDA Bull. 1307 (1924)-exhibit D-4 of the petition) explored this possibility and found no demonstrable effect of re-evacuating as much as six times.

(4)

At any rate we may calculate the theoretical maximum of fumigant available for absorption in the commodity, on the grounds that it would not be more than maximum vacuum fumigation dosage rate, in lbs., per such weight of commodity, in lbs., as will occupy 1000 cu. ft. This assumes that the fumigant concentration, by volume, in the bulked product is no greater than its volume concentration in the unoccupied space of the chamber. This is obviously a valid maximum unless there be some mechanism by which the fumigant soaks up fumigant preferentially, like a sponge soaks up water. HCN might be expected to soak into wet products preferentially, but it is not probable that such a phenomenon would occur with the dried products covered by this petition. Moreover, the known readiness with which HCN desorbs from such products dictates against the likelihood that they absorb it preferentially.

The attached tabulation in column 4 gives our computations of the maximum parts per million of HCN available for absorption from maximum dosage contemplated in vacuum fumigation of the various products. Such dosage is not given in the petition for peas, beans, and cocoa beans. For warehouse fumigation, however, the dosage for peas and beans is given as 1 to 1.5 lb./1000 cu. ft., the same as for popcorn. The latter, as "~~given~~ grain in bags" is listed as requiring vacuum fumigation dosage of 3 to 4 lb./ 1000 cu. ft. Accordingly, we have assumed that peas and beans would receive similar vacuum dosage. At any rate it would not be higher since any higher than 4 lb./1000 cu. ft. dosage is reserved for exceptionally dense products, which peas and beans obviously are not. Cocoa beans are of a physical nature similar to nut meats, for which a maximum dosage of 2.5 lb./ 1000 cu. ft. is given. We accordingly assume that dosage for cocoa beans.

In arriving at the values of column 4 we have employed the bulk densities given in column 3. We have not been able to ascertain the precise bulk densities in some instances, as indicated, but have approximated them with sufficient certainty for our purposes, as will appear from our final conclusions.

The values of column 4 are comparable to values for available HCN which we used in computing residues to be expected from fumigation with calcium cyanide--petition No. 39. In that case we concluded that residues expected would approximate no more than 25% of HCN available. The circumstances of availability of HCN from $Ca(CN)_2$ fumigation are at least as favorable for residue uptake as they are from vacuum fumigation with liquid HCN.

For these reasons we show, in column 5, the maximum residues to be expected, from the fumigant treatment contemplated, as 25% of the fumigant available for absorption. Since the latter was computed in a way to assure that it be overestimated rather than underestimated, we can be sure that our residue estimates are on the high side of actual, rather than the low side.

Nuts in the shell, which are given a relatively low dosage, would not be expected to incure residue as high as that on other commodities. We think it inadvisable to apply a lower tolerance to them, however, since there would be no way of telling whether a sample of nut meats carrying a higher residue had been fumigated in shelled or unshelled condition.

In all other circumstances we conclude that maximum residues to be expected would approach 25 ppm. It would be convenient to establish the tolerance for residues from liquid HCN at the same level as that from calcium cyanide. For reasons given we are satisfied that this would be practicable and we so recommend.

Except for nuts, all of these products are processed and/or cooked before being eaten. The tolerance of 25 ppm would serve to cover the residue expected even before any substantial aeration. Hence, except in the case of nuts, it is highly improbable that more than a small fraction of the tolerated residue would ever be actually consumed.

Peanuts are almost always roasted before being eaten, and residue consumed with them would therefore likewise be substantially reduced.

The other nuts, if fumigated shelled, might retain an appreciable residue when consumed.

A special circumstance respecting lima beans should be noted. This variety of bean contains a cyanogenetic glucoside. Varieties grown in the U.S. may contain HCN equivalents of up to 60 ppm. In other parts of the world, particularly southeast Asia, varieties are grown which carry much higher HCN potentiality--up to 900 ppm. Ordinary methods of cooking can be relied upon to dispell the HCN from domestic limas almost completely. For those unfamiliar with safe methods of preparing them, the so-called Rangoon and Burma beans are dangerous.

It is entirely feasible to distinguish analytically between HCN as fumigant residue, and HCN derived from cyanogenetic glucoside. In applying a residue tolerance of 25 ppm to lima beans, this aspect of regulatory practice should obviously be observed--but, as formerly, we should continue to apply appropriate restrictions on importations of cyanogenetically dangerous beans.

The petition requests a zero tolerance for HCN in meat. Packing plants are fumigated for control of rodents at dosage not more than 4 oz./1000 cu. ft. even to deal with difficultly accessible rodent harborage. Taking the density of meat as the same as that for water, we compute that HCN available for absorption in meat from such dosage is of the order of 10 ppm. While we have no basis to apply the 25% factor to meat, we think the appropriate factor would more likely be lower, in view of the relative impenetrability of meat. Accordingly, we would expect no more than a few ppm residue in consequence of this fumigation practice and would regard a zero tolerance as practicable. There would be an advantage in establishing it, as it would tend to discourage careless use of HCN in meat plants.

FRANK A. VORHES, Jr.

Enclosure
Tabulation   CC: Food   FAVorhes:io

6

1 Dosage lb./1000 cu.ft.	2 Commodity	3 Bulk Density lb./bu.	4 Max. HCN avail.* for absorption ppm	5 Estimate Max.** Residue ppm
4	Rye	56	89	22
4	Barley	48	104	26
4	Wheat	60	83	21
4	Corn	56	89	22
4	Popcorn	56	89	22
3.75	Rice-rough	45	104	26
3.75	Rice-polished	ca 60	78	20
4	Navy beans	60	83	21
4	Lima Beans	56	89	22
4	Kidney beans	60	83	21
2.5	Cocoa beans	35	89	22
4	Peas	60	83	21
4	Cowpeas	60	83	21
4	Chickpeas	60	83	21
4	Blackeye peas	60	83	21
0.8	Walnuts	50	20	5
2.5	" shelled	ca 35	89	22
0.8	Pecans	ca 50	20	5
2.5	" shelled	35	89	22
0.8	Peanuts	22-30	45	11
2.5	" shelled	38-44	82	21
0.8	Almonds	ca 30	33	8
2.5	" shelled	ca 41	76	19
2.5	Cashews (always shelled)	ca 41	76	19

$$* = \frac{\text{Max req'd dosage (lb./1000 cu. ft.)} \times 1.244 \text{ (cu. ft. in 1 bu.)}}{\text{Bulk Density (lb./bu.)} \times 1000}$$

** = Col 4 x 0.25 - see petition No. 39